AN EVALUATION OF TECHNIQUES FOR CAPTURING RAPTORS IN EAST-CENTRAL MINNESOTA

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ABSTRACT. To meet the objectives of a study, several species of raptors had to be trapped on a 9,880-hectare study area of heterogenous habitat types. Bal-chatri, mist net, Swedish Goshawk, and automatic bow-net traps (and combinations of these traps) were used in several general habitat situations. Mist nets combined with a baited bal-chatri or tethered bait were most successful in capturing birds, and the bal-chatris alone and mist nets alone were next most effective. Trapping was found to be most productive in deciduous upland habitats where an opening in the canopy or break in the understory occurred. Trapping along a woodlot-field edge was also effective. Strigiformes were most often trapped just before sunrise or just after sunset, while falconiformes were most often captured in the late morning and late afternoon. Trapping was least efficient from December to February. A different trap type from that used in the initial capture is often most effective for recapturing raptors. Maintenance of healthy bait animals and frequent trap checks are emphasized.

Introduction

This paper presents results from a combination of methods used to capture and recapture Great Horned Owls (*Bubo virginianus*), Barred Owls (*Strix varia*), Red-tailed Hawks (*Buteo jamaicensis*), and Broad-winged Hawks (*Buteo platypterus*) on a 9,880-hectare study area in east-central Minnesota. Additional information regarding the capture of Saw-whet Owls (*Aegolius acadicus*), Long-eared Owls (*Asio otus*), Goshawks (*Accipiter gentilis*), Red-shouldered Hawks (*Buteo lineatus*), and a Harrier (*Circus cyaneus*) are included.

We found no data quantifying the results of trapping that employed a combination of techniques on a specific study area; however, there have been numerous papers describing various traps and techniques for capturing birds of prey (Berger and Mueller 1959; Ellis 1975; Gromme 1937; Hamerstrom 1963; Meng 1963, 1971; Nicholls 1973; Robards 1967; Stewart et al. 1945; Tordoff 1954). Several falconry books also provide historical information on techniques used for catching raptors (Beebe and Webster 1964; Mavrogordato 1974; Peeters and Jameson 1970). Other papers have been concerned with the effectiveness of particular types of traps and methods by improving an old design (Henderson 1962, Kirsher 1958, Ward and Martin 1968, Whitman 1960). Data useful in assessing the utility of a particular trap for a particular species (Berger and Mueller 1959, Ellis 1975, Hamerstrom 1963, Henderson 1962, Kirsher 1958, Robards 1967, Stewart et al. 1945) or for a particular situation (Clark 1971, Ellis 1975, Berger and Hamerstrom 1962, Berry 1971, Hamerstrom 1963, Meng 1971, Nicholls 1973, Stewart et al. 1945) can be helpful to researchers designing studies which involve the capture of birds of prey.

The Study Area

The study was conducted on the Cedar Creek Natural History Area (93° 12'E, 45°24'N) in a variety of habitats including oak uplands, mixed deciduous and coniferous uplands, white cedar (*Thuja occidentalis*) lowlands, tamarack (*Larix laricina*) lowlands, deciduous shrub lowlands, marshes, and open fields. Nicholls and Warner (1972) described these habitats in more detail and provided a general phenology for the study area. For the purpose of analyzing trapping data the following habitats were recognized: (1) deciduous opening (a break in the canopy of a deciduous upland woods at least 6 m in diameter); (2) deciduous trail (a break in the understory of a deciduous upland woods at least 3 m by 3 m that may be an actual trail through the woods); (3) field-woods edge; (4) deciduous-conifer trail (opening or trail like #2 but through a mixed deciduous-conifer upland); (5) deciduous-conifer opening (an opening in the canopy like #1 except in a mixed deciduous-conifer upland); and (6) open field.

Methods

Several trap types and combination of traps were used during the study. Trap types included (1) two-shelf 121-mm mesh, 12-m-long mist nets (Nicholls 1973); (2) modified bal-chatri traps (berger and Hamerstrom 1962, Ward and Martin 1968) of either a 0.7-square-cm hardware cloth cage, 10 cm x 20 cm, or a 2.5-cm chicken-wire cage, 25 cm x 35 cm, for mouse or pigeon bait, respectively; (3) Swedish Goshawk traps (Meng 1971); and (4) a modified automatic bow-net (Tordoff 1954). Trap combinations included putting a bal-chatri or tethered bait or decoy in front of a line of one to three mist nets, or in a V formed by two mist nets or in the middle of a triângle of mist nets. The triangle was formed by stringing one net lengthwise and staking another in a V shape, with the open end of the V against the lengthwise net. A baited bal-chatri was placed under the trigger mechanism of the automatic bow-net.

Trap placement in 1971-1972 was based on the valuable advice of Nicholls (pers. comm.) and Hamerstrom and Hamerstrom (pers. comm.). During 1972-1973 we reduced the total number of trap sites and altered locations because of our experience from the previous field season. Generally, traps were placed in areas where raptors had been observed in the habitats described. Nets were placed at the edges of openings or perpendicular to trails (see Nicholls 1973) and on field-woods edges. Bal-chatris, Swedish Goshawk traps, and the bow-net were placed in fields or on field-woods edges. Bal-chatris were also dropped from vehicles near perched or soaring raptors in the manner described by Berger and Mueller (1959).

Pigeons (*Columba livia*) were frequently used as bait because of ease of maintenance and their heartiness (Berger and Hamerstrom 1962). We also used brown and white laboratory mice (*Mus musculus*); hooded and white laboratory rats (*Rattus norvegicus*); game-farm Ring-necked Pheasants (*Phasianus colchicus*); domestic rabbits (*Oryctolagus cunniculus*); gerbils (*Meriones unguiculatus*); and Starlings (*Sturnus vulgaris*) and Common Grackels (*Quiscalus quiscula*) obtained from pest-control programs. Decoy animals (Hamerstrom 1963, Anderson and Hamerstrom 1967) included Great Horned Owls and Red-tailed Hawks obtained from a raptor rehabilitation program (Fuller et al. 1974). Tethered pigeons and decoy animals were secured by leather jesses about their legs. Bait and decoy animals were given food and water at the trap site and were returned to holding cages at least two times each day depending on temperature and precipitation conditions. All traps were closed down during periods of extended or severe precipitation or when ambient temperatures fell below 10°F. These conditions were judged too stressful for bait and decoy animals, as well as for raptors if they should be trapped. Traps were checked every four hours or more frequently depending on weather conditions.

Results and Discussion

Trapping results using the various methods are presented in table 1. The combination of mist nets plus bal-chatri was most successful in terms of numbers captured and trap days per capture. The mist net with tethered bait was as efficient as mist nets plus bal-chatri but resulted in fewer total captures. The bal-chatri alone was next most productive both in terms of captures and efficiency. The mist net alone ranked only slightly below the bal-chatri. We captured only two birds in the Swedish Goshawk trap and were unsuccessful with limited use of the bow-net. Calculation of correlation coefficients (Clarke 1969) for trap days and captures provided no significant correlation between the two.

Table 1
Captures by Trap Type

Trap	Days Used	Tot. Capt.	D/C	Captures by Species									
				GHO	BO	LEO	SWO	RT	BW	RS	GH	CH	HA
Mist	#279	11	25		5		2	1	2			1	
	% 20	12			24		67	5	15			6	
Mist	#191	17	11		1	1		4	5	1		4	1
Teth.	% 13	18			5	100		18	38	20		25	100
Mist	#327	30	11		11		1	9	3	2	2	2	
B.C.	% 23	32			52		33	41	23	40	50	13	
Mist	# 91	7	13	3				1		1	1	1	
Dec.	% 6	8		43				5		20	25	6	
B.C.	#324	14	23	1	2			3	3	1	1	3	
	% 23	15		14	10			14	23	20	25	19	
Swed.	#182	2	91	1				1					
Gos.	% 13	2		14				5					
Bow-	# 34												
net	% 2												
Hand*	#	12		2	2			3				5	
	%	13		29	10			14				31	
Total	1428	93		7	21	1	3	22	13	5	4	16	1

*Hand-capture data not included in total trap days or days per capture calculations.

GHO = Great Horned Owl
BO = Barred Owl
LEO = Long-eared Owl
SWO = Saw-whet Owl
RT = Red-tailed Hawk
BW = Broad-winged Hawk
RS = Red-shouldered Hawk
GH = Goshawk
CH = Cooper's Hawk
HA = Harrier

The capture of each species by trap type is also presented in table 1. Again the combinations of mist net plus either bal-chatri or tethered bait gave the best results. The bal-chatri alone appeared to be more efficient for falconiformes than for strigiformes when compared to other methods. Great Horned Owls were used effectively as decoy animals in efforts to trap other Great Horned Owls. Hawks trapped by this means were caught incidentally to the efforts directed at Great Horned Owls. However, the attacks by hawks on Great Horned Owls flushed during the day (Dunstan and Harrell 1973, Murphy et al. 1969) and the success of this owl as a decoy (Hamerstrom 1963) suggest that this technique can be widely applied. Barred Owls would probably avoid a Great Horned Owl decoy because of apparent interspecific conflicts which occur between these two species (Fuller et al. 1974). No Barred Owls were available as decoy animals. Mist nets with bal-chatris and mist nets alone were most effective for capturing Barred Owls. These same two techniques were used successfully to capture Red-tailed and Broad-winged Hawks though these species were trapped with a variety of trap types.

An important point to note here and to bear in mind throughout the discussion is that our trapping efforts were restricted to a study area, and the densities of all species on the area were not equal. These differences in density are reflected in the "total capture by species" row of table 1. For example, Barred Owls and Red-tailed Hawks were more numerous on the area, and therefore more likely to be trapped, than Great Horned Owls or Broad-winged Hawks. Additionally, our efforts were concentrated on these four species. These data cannot be viewed as the result of an experiment, or random sample, designed to test the effectiveness of all trap types in all habitat types on all species.

When trapping on a specific study area, trap placement is an important consideration. Table 2 presents data concerning capture success in the six habitat types in which we trapped. There was no significant correlation between the number of days we trapped in a habitat and the number of captures. The deciduous uplands appear to be suitable habitats for trapping nearly all species, and traps placed under openings in the canopy of a deciduous upland resulted in the greatest number of raptors caught. Traps along trails or openings in the understory in deciduous upland produced the most efficient trapping in terms of trap days per capture. Great Horned Owls, though not trapped in the uplands, were known to use these habitats and openings. These owls and two Goshawks were trapped at field-woods edges or in fields. The woodlots, in these cases, were deciduous uplands. The trapping data for three of the Great Horned Owls and three of the Goshawks reflect the logistics of our winter trapping. It was easier to set traps near access roads or trails when the snow was deep. These trails most frequently ran along the edges of woodlots. In light of this bias it appears that all species use deciduous woodlots, except the Long-eared Owl, which is known to use coniferous and field habitats in the upper midwest (Christenson and Fuller 1975, Nicholls 1962).

The importance of openings and edges is further emphasized by trapping results from the mixed deciduous-conifer opening habitat. Raptors apparently use openings and trails to their advantage in several ways. First, these breaks in the habitat provide pathways of unobstructed flight—particularly for the Barred Owl (Nicholls 1973). Secondly, edges and openings furnish effective hunting perches for the sit-and-wait type of predator with relatively unobstructed view and flight path toward the prey. The raptor is also afforded some protection from inclement weather and predators. Though bait or decoy animals would seem visible in the open-field situation, these sets did not prove productive. The mixed deciduous-coniferous trail habitat was probably not trapped enough to yield conclusive results.

Table 2
Captures by Habitat Type

Hab.	Days Used	Tot. Capt.	D/C	Captures by Species GHO	BO	LEO	SWO	RT	BW	RS	GH	CH	HA
Decid.	#371	32	11		10		3	6	5	3		4	11
Open	% 26	40			53		100	32	38	60		36	100
Decid.	#140	19	7		5			5	5		1	3	
Trail	% 10	23			26			26	38		25	27	
Field/	#323	18	18	4	2			5	2	1	2	2	
Woods	% 23	22		80	11			26	15	20	50	18	
Decid.	#157	8	17		2			2	1	1		2	
Conif.	% 11	11			11			11	8	20		18	
Open.													
Decid.	# 56	1				1							
Conif.	% 4					100							
Trail													
Field	#381	3	127	1				1			1		
	% 27	4		20				5			25		
Total	#1428	81		5	19	1	3	19	13	5	4	11	1

*See Table I for key.

Long-eared Owls are uncommon on the Cedar Creek Natural History Area; therefore, the single capture is not unusual. Saw-whet Owls are nesting residents on the area and generally use cedar and tamarack lowland-mixed/deciduous-coniferous upland edges at that time (Forbes and Warner 1974, Nicholls pers. comm.). The three birds we captured were all trapped in deciduous uplands in March. These observations agree with other reports on habitat use by Saw-whet Owls during spring migration (Catling 1971). Goshawks are winter visitors on the area, utilizing a variety of habitat types. Red-shouldered Hawks did not nest on the area during this study, but successful Red-shouldered Hawk nesting does occur along nearby rivers (Malone, Christenson, and Fuller unpublished data), and we have observed nesting attempts adjacent to lakes. All Red-shouldered Hawks captured on the Cedar Creek Natural History Area were immature birds, either from the previous year (and therefore probably not attached to a nesting territory) or young of the year.

The Harrier is not an uncommon bird; two pair nested on the area. The Harrier trapped, an incubating female, was taken in deciduous opening about 200 m from her nest. The bird was flushed twice from the triangular mist net and bal-chatri (pigeon bait) set. Each time she "helicoptered" off the trap and up over the top of the nets. The third time we rushed the net, and she flew into it and was captured. With the exception of a Swedish Goshawk trap set 30 m from her nest, no efforts were made to trap nesting Harriers. Observations on this female and another female with young showed that these birds were fairly restricted in their movements, often flying over and perching in woodland habitats adjacent to the nesting marsh. Successful efforts to trap Harriers are described by Hamerstrom (1963) and Berger and Hamerstrom (1962).

One of the objects of the study at the Cedar Creek Natural History Area was to monitor the movements and activity patterns of both diurnal and nocturnal raptors. Therefore our traps were generally set 24 hours a day. Figure 1 presents the capture distribution by time of day. Since our traps were checked as infrequently as once each four hours, a capture time of 0600 may represent a bird that actually entered the trap at 0200. As might be expected, most of the owl captures occurred during the night, dawn, and dusk periods. Two owl-capture peaks occur: predawn and postdusk. Hawks were trapped during the day, exhibiting capture peaks in late morning and late afternoon. Mueller and Berger (1973) found falconiformes were trapped with equal frequency throughout the day during fall migration. We have no comparative data for hawks during September, October, and November. It is possible that seasonal differences in behavior account for the different trapping results.

The results of our trapping by season are presented in table 3. As seen from the trap days per capture, our efficiency was low in January and December. Our effort was also substantially reduced during these months, but calculation of a correlation coefficient resulted in no significant correlation between the number of trap days per month and the number of captures.

Table 3
Trapping Efforts and Success by Month

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	T-C
GHO			1		1	1						2	5
BO	2	1	2	1	1	2	3	3	2	1		1	19
LEO								1					1
SWO			3										3
RT			2	4	2	6	4	1					19
RS			1	1		1	1	1					5
GH		1	2								1		4
CH			1	5	1	3	1						11
HA					1								1
BW				1	4	4	2	1	1				13
Total	2	2	12	12	10	17	11	7	3	1	1	3	81
Trap Days	95	44	213	228	156	178	208	106	67	21	15	97	1428
TD/C	48	22	18	19	16	11	19	15	22	21	15	32	

Nine raptors were recaptured one or more times during the study (not including captures by hand). Table 4 illustrates that the time of capture varies considerably from capture to recapture, whereas most birds were retrapped in the same or similar habitat associations. The type of trap involved in recaptures was often different from that successful in first-trapping the bird. The Great Horned Owl was initially captured with a pigeon in a bal-chatri. Tracks in the snow revealed that the set had been struck and dragged prior to being checked at 2200 and again at 2400. At 0100 the owl was found caught in the nooses—the same bird that was

recaptured three months later. Radio-location data (Fuller and Tester 1973) showed that this bird had had numerous opportunities to go after pigeons in bal-chatri sets during the three-month interval prior to recapture. It was not until a mist net with a Great Horned Owl decoy was set adjacent to the woodlot where this owl's nest was that he was recaptured. Similarly, Barred Owl #725 often perched around an opening in which a mist net was set. This bird had been captured in a mist net but was not retrapped until the first night a pigeon in a bal-chatri was added to the set. These data suggest that attempts to recapture raptors be undertaken with a different type or combination of trap types.

Table 4
Capture-Recapture Data

An #	Sp[a]	Date	Time	Hab[b]	Trap[c]	B/D[d]
719	GHO	12-10-71	0130	6	5	P
		03-10-72	0330	3	4	GHO
717	BO	12-08-71	0615	3	5	P
		05-25-72	0340	1	1	–
		09-27-72	2100	1	3	P
720	BO	06-28-72	1930	2	1	–
		07-19-72	0530	2	1	–
		08-08-72	2100	3	3	P
		03-06-73	–	2	3	P
725	BO	07-06-72	2215	1	1	–
		08-03-72	0615	1	3	P
831	GH	02-21-73	1630	3	4	P
		03-15-73	0830	3	3	GHO
813	RT	04-24-72	1745	2	5	P
		07-07-72	1115	1	2	–
836	RT	04-04-73	1800	3	4	GHO
		07-10-73	1100	2	3	P
808	CH	04-06-72	1730	3	5	P
		06-29-72	2100	1	4	GHO
812	CH	04-24-72	1015	2	5	P
		04-26-73	–	1	3	P

[a] See Table 1

[b] 1 = deciduous open
2 = deciduous trail
3 = field/woods
4 = deciduous/coniferous woods
5 = deciduous/coniferous open
6 = field

[c] 1 = mist net
2 = mist net and tethered pigeon
3 = mist net and bal-chatri
4 = mist net and decoy
5 = bal-chatri

[d] bait/decoy
P = pigeon

Our incomplete data for bait type used during successful captures and our bias with the use of pigeons make analysis of success with different bait animals impractical. All species captured were represented by cases when the bait animal was a pigeon. It is doubtful that the Saw-whet Owl was attempting to capture the pigeon, but it is not unreasonable to assume that other species were attracted by pigeons. If one is more concerned about capturing species like Cooper's Hawks, more efficiency might be obtained with smaller bait animals.

Some general considerations regarding use of trap types are worth mentioning here. There are positive and negative aspects of the use of any of these traps. The main considerations in trapping for our study were ability to trap several species within a limited area in several habitat types and the necessity to use traps which did not require constant vigilance. The bal-chatri is fairly effective and easily transported and placed, but birds sometimes break the nooses or escape from them. Mist nets should be set up in a situation providing a dark background to camouflage the net. Also, protection fro the wind is desirable because when the "bag" of the net is blown by the wind, raptors may "bounce" off the net. The combination of mist net and baited bal-chatri appears to increase the capture efficiency above either of these types used separately (see table 1). This efficiency may be due to several circumstances: (1) birds may be attracted to an area by the bait and trapped in the net while flying by; (2) they may be trapped when going in on the bait; or (3) they may be trapped in the net after an encounter with the baited bal-chatri.

The mist net plus tethered bait was as efficient as the mist net plus bal-chatri. The advantage of the bait method may be that birds reluctant to go in on the "foreign" wire trap are attracted to the more natural-appearing tethered pigeon. A disadvantage is that if the bird is not netted, it may take the bait and escape. One might try adding a noose carpet (Anderson and Hamerstrom 1967) to this combination for increased efficiency. The maintenance of nooses, whether on a bal-chatri or noose carpet, is time-consuming.

One automatic bow-net was used to a limited extent. This technique, using either tethered bait or bait in a bal-chatri, could be very useful (see Matray 1974) because it is easily transported and set up, and, if camouflaged, it is inconspicuous. One would have to use a hoop large enough to capture the largest bird likely to be caught. Also, the apparatus would have to be staked down and a safety latch used so the raptor could not escape under the frame or hoop. The Swedish Goshawk trap is easily set, and bait animals can be left in it continually when food, water, and some shelter are provided. It was not very efficient for our study of resident birds, however. Such birds become familiar with their surroundings and its contents (Southern 1970, Nicholls 1973). The framework of the Swedish Goshawk trap may dissuade resident birds from attempting to obtain the bait. Where raptors are attracted to unusual concentrations of prey, such as on game farms (Meng 1971), or during periods when winter visitants or dispersing birds are in an area, the Swedish Goshawk trap may be very effective.

Finally, we wish to make some suggestions regarding raptor trapping in general. Once trap types have been chosen and made ready for the field, one must have a supply of bait and/or decoy animals and adequate facilities for their maintenance. As Berger and Hamerstrom (1962) have emphasized, healthy bait animals are essential for good trapping. The bait animals should be checked frequently in the field and replaced regularly depending on the environmental conditions. Similarly the traps should be checked as frequently as possible. When trapped or bait birds are exposed to direct sunlight, wind, or precipitation, they may undergo stressful conditions. Added to this problem is the struggle captured raptors or bait birds put up in efforts to escape.

Raptors may injure themselves in mist nets. We had one Goshawk and several Barred Owls that upon release would not fly and showed signs of wing injuries. Subsequent examination revealed no broken bones or other serious injuries, but the birds had obviously strained their wing muscles. Raptors may also pierce their bodies with their talons while trying to escape. In struggles to free themselves they may attract other raptors to the trap. We had several multiple captures; Berger and Hamerstrom (1962) also report multiple captures. Thus the potential for one raptor to prey on another exists, and trapped raptors are also vulnerable to mammalian predators. All this points to the need for frequent trap checks. Raptors can be removed from the trap and held safely for some time before processing (Fuller 1975). When capturing birds by hand from the nest or roost, care must be taken not to leave a scent trail for mammalian predators, such as raccoons (*Procyon lotor*), to follow. Napthalene crystals can be used to cover one's scent. They may also be spread around the tethered bait or bait animal in a bal-chatri to discourage mammalian predation.

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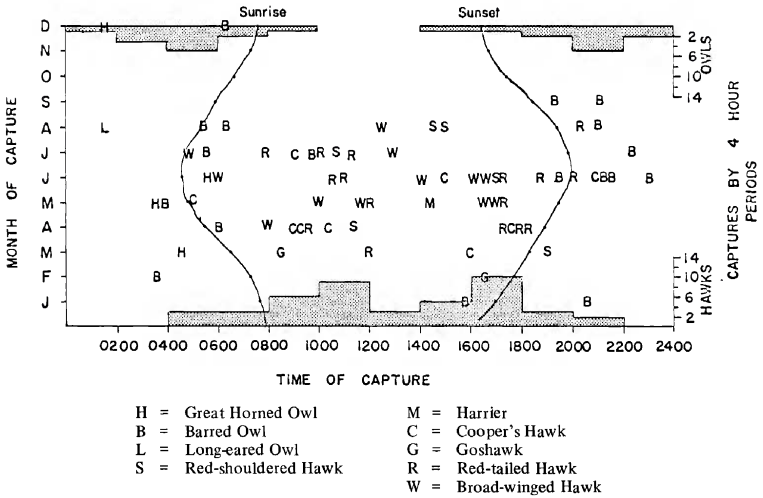

Figure 1. Capture Distribution of Species by Time of Day